REMARKS

Claims 1-6 are pending in the subject application. Favorable reconsideration in light of the remarks which follows respectfully requested.

1. Drawings

The drawings of Fig. 1, Fig. 4, Fig. 7 and Fig. 8 have been objected to. The Examiner states that:

> the ratios of Cl2:Al and BCl3:Al appear to be a typographical error since the examiner believes that the applicants intend to refer to the ratio of Cl2:Ar and BCl3:Ar as disclosed in pages 7-9 of the specification.

As suggested, Applicants submit herewith proposed drawing corrections to correct the typographical errors noted by the Examiner. Reconsideration and withdrawal of the drawing objections is respectfully requested.

2. 35 U.S.C. §102 Rejections

Claim 1 has been rejected under 35 U.S.C. §102(b) as being anticipated by Yang et al (US 5,827,437). The Office asserts:

> Yang discloses a multi-step plasma etch method using a process gas(comprises of two gaseous components of Cl_2 and BCl_3) (col 6, lines 4-5), the process gas is supplied into a plasma process chamber 204 to generate a plasma to plasma etching/process a substrate 206 (col. 5, lines 23-48). Yang discloses that the wafer/substrate includes stacked layers of alumina and Ti barrier layer, the aluminum and Ti layer are plasma etched (col 10, lines 53-59, col 11, lines 8-25), which reads on the substrate includes stacked films of at least two types to be etched by the plasma. Yang also discloses that during the main etch step/period to etch the metallization/aluminum layer, the mixture flow ratio between the two gaseous components (Cl_2 and BCl_3) is changed (col 12, lines 16-25, fig. 3A), which reads on according to any of the stack layers/films is to be etched, a change is made in the process gas in a plasma generation period.

Applicants respectfully traverse.

Applicants claim, in claim 1, a plasma processing method using a process gas supplied into a process chamber to generate plasma from the process gas and process a substrate placed in said process chamber by means of the plasma, wherein the substrate includes stacked films of at least two types to be etched by the plasma, and,

according to any of said films that is to be etched, a change is made in said process gas in a plasma generation period.

The Yang reference, on the other hand, describes a multi-step metallization etch. In particular, the Yang reference describes a multi-step metallization process that minimizes the profile microloading associated with etching the metallization layer of a layer stack. As set out by Yang, the multi-step process includes a conventional pre-etch step 302, followed by a main etch step 304, and optionally followed by an over etch step 306 (see, e.g., col. 7, lines 18-39; Fig. 3A). A barrier layer etch step 310 can optionally be included between the main etch step 304 and over etch step 306 (see, e.g., col. 7, lines 59-63; Fig. 3B). In the main etch step 304, a relatively high flow ratio of Cl_2:BCl_3 is used (see, e.g., col. 7, lines 26-31). The over etch step uses an even higher Cl_2:BCl_3 flow ratio than that used in the main etch step (see, e.g. col. 7, lines 48-51). Thus, during the main etch step, a main-etch etchant source gas is used and during the over etch step, an over-etch etchant source gas is used (see, e.g., col. 3, lines 34-42).

Thus, contrary to the Offices' assertion, Yang does not describe or suggest that during the main etch step, the mixture flow ratio between the two gaseous components (Cl_2 and BCl_3) is changed. Rather, Yang describes and shows in the Figures that a first Cl_2:BCl_3 ratio is used in the main etch step and that a second Cl_2:BCl_3 ratio is used in the over etch step.

Further, col 12, lines 16-25, which were cited by the Examiner as describing that during the main etch step, the mixture flow ratio between the two gaseous components (Cl_2 and BCl_3) is changed merely states that the method comprises:

> performing a main etch by etching at least partially through said metallization layer of said layer stack with a main-etch etchant source gas that comprises Cl_2 and BCl_3 and having a first Cl_2:BCl_3 flow ratio; and
> thereafter, performing an over etch by etching through a remainder of said metallization layer to a layer underlying said metallization layer with an over-etch etchant source gas that comprises Cl_2 and BCl_3 and having a second Cl_2:BCl_3 flow ratio that is higher than said first Cl_2:BCl_3 flow ratio.

Thus, contrary to the Offices' assertion, Yang does not describe or suggest that during the main etch step, the mixture flow ratio between the two gaseous components (Cl_2 and BCl_3) is changed.

The present invention, according to claim 1, provides that a change is made in the process gas in a plasma generation period. On the other hand, Yang does not describe or suggest that, in the main etch (illustrated in Figs. 3A and 3b), the mixture ratio of the process gas, the type of the gas and the like are changed. Moreover, Yang does not describe or suggest that, in the over etch, the mixture ratio of the process gas, the type of the gas and the like are changed. Further, Yang does not disclose that the main etch and the over etch are successfully performed while plasma is generated (in a plasma generation period). Thus, it is clear that Yang does not describe or suggest the feature of the present invention that a change is made in the process gas in a plasma generation period.

Thus, claim 1 is patentable over the Yang reference.

3. 35 U.S.C. §103 Rejections

Claim 2 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Yang et al (US 5,827,437) in view of Chung (US 5.658.820). The Office asserts:

> Yang's method has been described above in paragraph 5. Unlike the instant claimed invention as per claim 2, Yang does not disclose changing the bias voltage applied to the substrate together with the change made in the process gas/changing the gas mixture ratio in the plasma generation period/etching period.
>
> However, Chung discloses a method for manufacturing a ferroelectric capacitor by etching a stacked layer structure comprises the step of increasing/changing the DC bias voltage applied to the substrate holder while varying the gas mixture ratio during the etching period (col. 4, lines 4-44). Chung teaching reads on changing the bias voltage applied to the substrate together with the change made in the process gas/changing the gas mixture ratio in the plasma generation period/etching period.
>
> Hence, one skilled in the art would have found it obvious to modify Yang's method by changing/increasing the DC bias voltage applied to the substrate holder while varying the gas mixture ratio during the etching period as per Chung because according to Chung increasing

> the bias voltage is one of the optimum condition for increasing the selectivity of one layer with respect to the other layer in the stacked structure (col 4, lines 59-63)

Applicants respectfully traverse.

As set forth, contrary to the Office's assertion, Yang does not describe or suggest a multi-step plasma etch method wherein during the main etch step, the mixture flow ratio between the two gaseous components (Cl_2 and BCl_3) is changed or wherein a change is made in the process gas in a plasma generation period. Rather, Yang describes and shows in the Figures that a first Cl_2:BCl_3 ratio is used in the main etch step and that a second Cl_2:BCl_3 ratio is used in the subsequent over etch step.

Further, Chung does not remedy the deficiencies of the Yang reference set forth above. Chung describes a method for manufacturing a ferroelectric thin-film wherein during an etching step, (a) Ar, chloric and fluoric gases of a predetermined composition ratio are injected into the etching chamber, (b) an RF power of a predetermined frequency and power are applied to an RF coil to generate an inductively coupled plasma in the chamber (see Abstract; col. 1, line 61 – col. 2, line 2). In order to determine the optimum predetermined composition ratio and frequency and power, experiments were carried out wherein the composition ratio and frequency and power were varied (see col. 4, lines 11-64). As set out by Chung:

> Summing up the above experimental results of the first embodiment, in the manufacturing of a capacitor having a ferroelectric thin-film of Pt/PZT/Pt, the optimum conditions for increasing the selectivity of the Pt electrode with respect to the PZT thin-film so as to etch the upper Pt electrode are: a power of the coil of greater than 600 W, a DC self bias voltage of above 300 V, and a gas pressure of below 5 mtorr as a Cl_2 and C_2F_6 content to the Ar content is 0-10%. (col. 4, lines 57-64)
>
> Summing up the above experimental results of the second embodiment, the optimum etching conditions are: a power of the coil of below 600 W, a DC self bias voltage of below 500 V, and a gas pressure of above 5 mtorr as a Cl_2 and C_2F_6 content to the Ar content is 30-40%. (col. 5, lines 16-20)

Thus, Chung does not disclose a method for manufacturing a ferroelectric capacitor by etching a stacked layer structure comprises the step of

increasing/changing the DC bias voltage applied to the substrate holder while varying the gas mixture ratio during the etching period (col. 4, lines 4-44). Rather, Chung describes a method for manufacturing a ferroelectric capacitor under predetermined composition ratio, frequency and power values. These predetermined values are determined through experimental procedures wherein these values are varied until the optimal value is determined. Then, during the method manufacturing the ferroelectric capacitor, the optimal predetermined values are used and are not varied.

Thus, claim 2 is patentable over Yang in view of Chung.

Claims 3, 4 and 5 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Yang et al (US 5,827,437) in view of Chung (US 5,658,820).

Applicants respectfully traverse for the reasons set forth above.

Claim 6 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Yang et al (US 5,827,437) in view of Abraham (US 6,004,884).

Applicants respectfully traverse for the reasons set forth above.

Further, Abraham does not remedy the deficiencies of the Yang reference as set out above. The Abraham reference describes a method and apparatus for etching semiconductor wafers. According to Abraham, in a first step, a first chemistry is used to etch through a TiN layer. The first chemistry includes a TiN etchant, a noble gas, and a polymer-forming chemical.

The Office asserts that

> Abraham discloses a method for plasma etching a stacked layers on a semiconductor wafer comprises the step of increasing the output of an upper RF power source while varying the gas mixture ratio during the etching period (col 5, lines 1-3, col 10, lines 33-41, Table 1).

Applicants respectfully disagree. According to the Abraham reference, Table 1 shows the approximate process parameters that may be suitable for the first chemistry

etch. In particular, Table 1 sets out an approximate range, preferred range and more preferred range of the top electrode power, bottom electrode power and flow rates. Thus, one may select a value for the top electrode power, bottom electrode power and flow rates from Table 1. Nowhere in the Abraham reference is it mentioned or described that these values are varied among these ranges during the etching period. Rather, these values are merely selected from the ranges.

Accordingly, claim 1 is patentable over Yang in view of Abraham. Claim 6 depends from claim 1 and, likewise, is patentable over Yang in view of Abraham.

CONCLUSION

Reconsideration and allowance of claims 1-6 is respectfully requested in view of the foregoing discussion. This case is believed to be in condition for immediate allowance. Applicant respectfully requests early consideration and allowance of the subject application.

Applicants, conditionally petition for an extension of time to provide for the possibility that such a petition has been inadvertently overlooked and is required. As provided below charge Deposit Account No. **04-1105** for any required fee.

Should the Examiner wish to discuss any of the amendments and/or remarks made herein, the undersigned attorney would appreciate the opportunity to do so.

Respectfully submitted,

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Lisa Swiszcz Hazzard (Reg. No. 44,368)
EDWARDS & ANGELL, LLP
P.O. Box 9169
Boston, MA 02209
Tel. No. (617) 517-5512